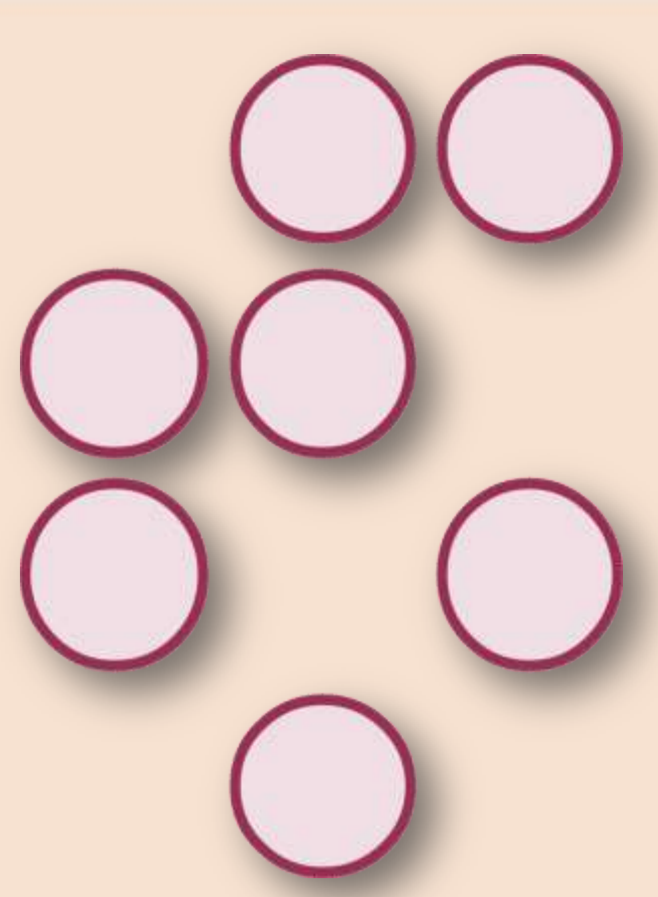


RADON CONCENTRATION AND VENTILATION IN TWO DIFFERENT PASSAGES IN THE POSTOJNA CAVE

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INTRODUCTION

Postojna Cave is the biggest of 21 show caves in Slovenia and one of the present day's most visited show caves in the world. Because of elevated radon concentrations in air it has been under permanent radon survey since 1995 (Vaupotič, 2008). This cave is a typical horizontal cave (Šebela, 1998) with one large natural entrance, used also as a tourist entrance (Fig. 1). Other entrances of the 20.5 km long cave system are scattered on the surface above the cave. Long and branched out cave system, large entrances at different levels, inflow of the Pivka river and large variation of the outdoor air temperature and precipitation, make Postojna Cave a very complex climatic system in which each part shows different conditions.

SITE DESCRIPTION AND MEASUREMENTS

Radon concentration was measured continuously at two different passages of Postojna Cave, in the Beautiful Caves (Lepe jame) and Gay-Coloured Corridor (Pisani rov). The first site is located in a narrow natural passage in the tourist part of the cave, characterised by numerous cracks in the faulted rocks, which play an important role in air ventilation. The second site is at the end of a 500 m long Gay-Coloured Corridor. This passage deviates from the main passage and has no other connection with the cave or outdoors. Radon was monitored from January 2006 to January 2010 in the Beautiful Caves and from February 2010 to January 2011 in the Gay-Coloured Galleries.

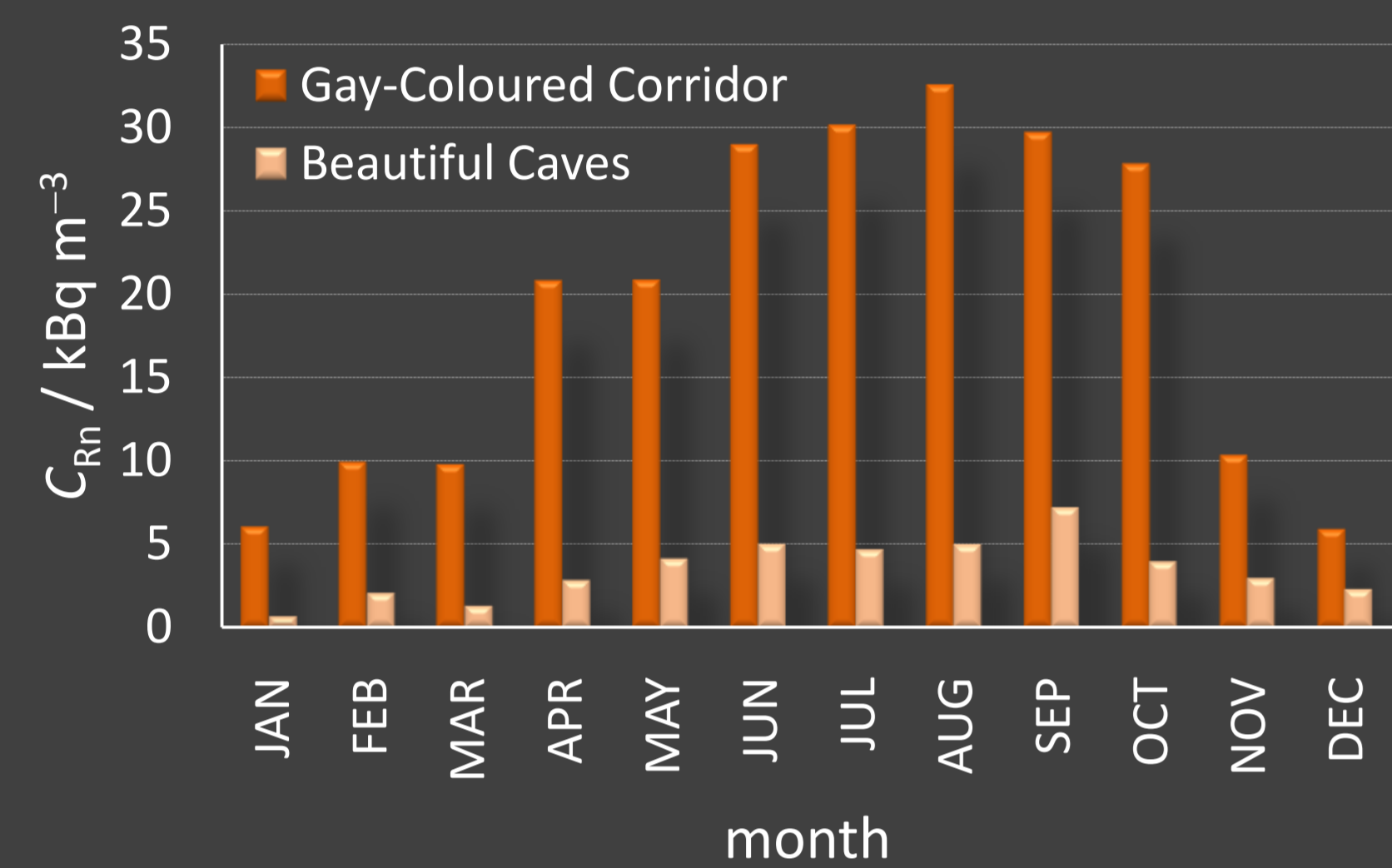


Fig. 2: Average monthly radon concentration in the Beautiful Caves and Gay-Coloured Corridor.

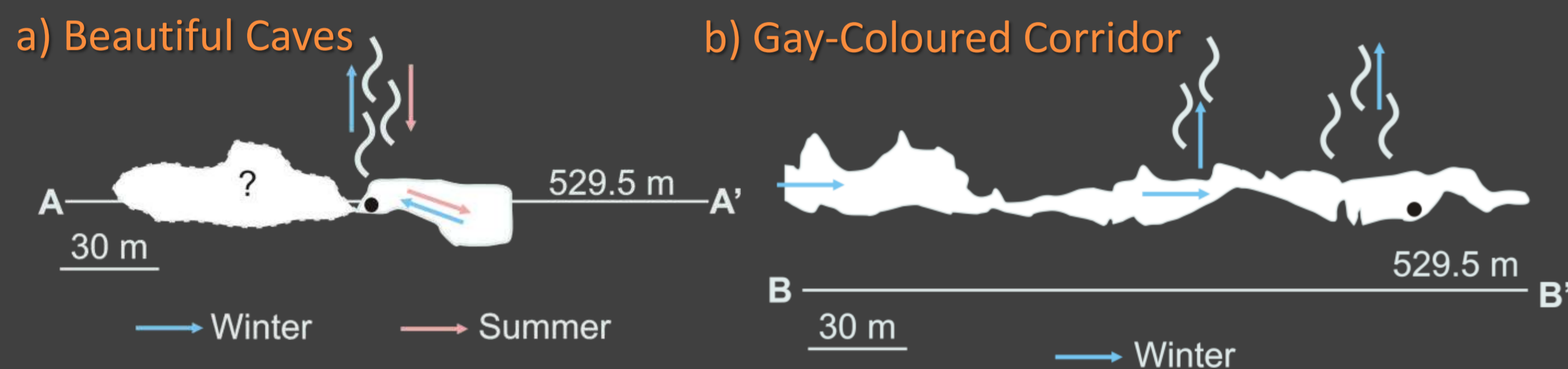


Fig. 4: Cross sections: a) Beautiful Caves (Šebela, 2011), b) Gay-Coloured Corridor with principal air movement in winter and summer. Measurement location is indicated by black circle.

SEASONAL RADON BEHAVIOUR

The seasonal pattern of radon concentration is mainly a result of air movement due to differences of the outdoor and cave air densities, determined mostly by air temperature. The cave temperature is fairly constant the whole year round within 9 to 10 °C.

Radon concentration was in the range from 0.2 to 10 kBqm⁻³ and 0.4 to 40 kBqm⁻³ in the Beautiful Caves and Gay-Coloured Corridor, respectively. The lowest radon concentration in the Beautiful Caves is in winter, from November to February (Fig. 2), when warm cave air causes a natural draught of lighter radon rich cave air from the cave upwards through vertical cracks and channels into the outdoor atmosphere, thus allowing the entry of fresh air into the cave through the main entrance and other lower entrances (chimney effect) (Fig. 3a). On the other hand the highest radon concentration is usually in early autumn, when outside temperature is in the range from 10 to 25 °C and the ventilation in the cave is minimal or zero. In summer the ventilation is reversed and the air flows from higher to lower entrances of the cave (Fig. 3b). The analyses of cave temperature in the Beautiful Caves (Šebela, 2011) points out to possible connection with an unknown cave passage.

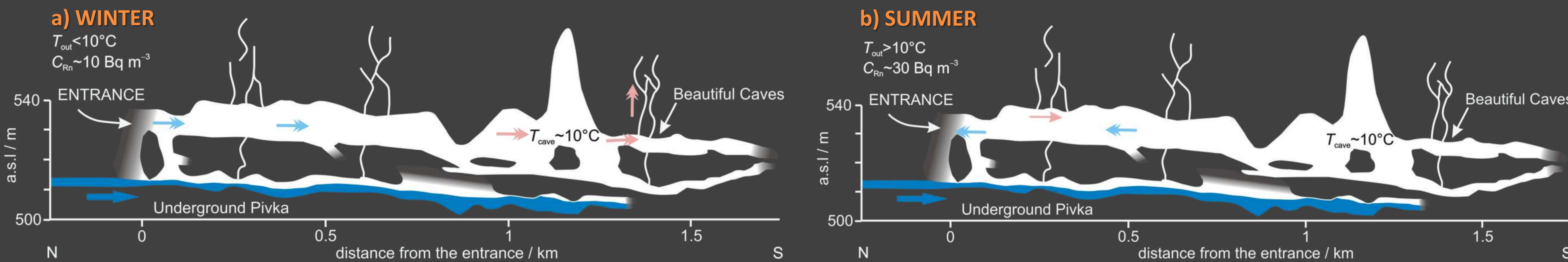


Fig. 3: Schematic longitudinal section of Postojna Cave and principal air movement in a) winter and b) summer.

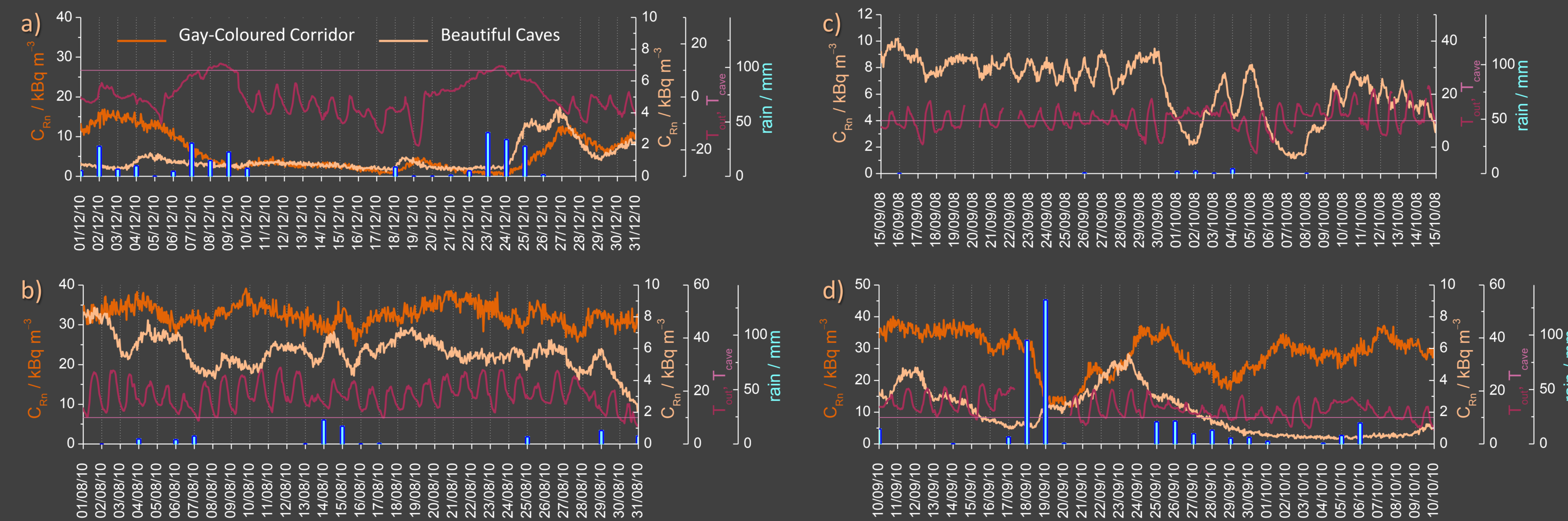


Fig. 5: Hourly values of radon concentration (C_{Rn}) in the Beautiful Caves and Gay-Coloured Corridor, outside and cave temperature (T) and amount of rainfall, showing different ventilation regimes: a) winter, b) summer, c) diurnal variation of C_{Rn} in the Beautiful Caves, d) the effect of heavy rain.

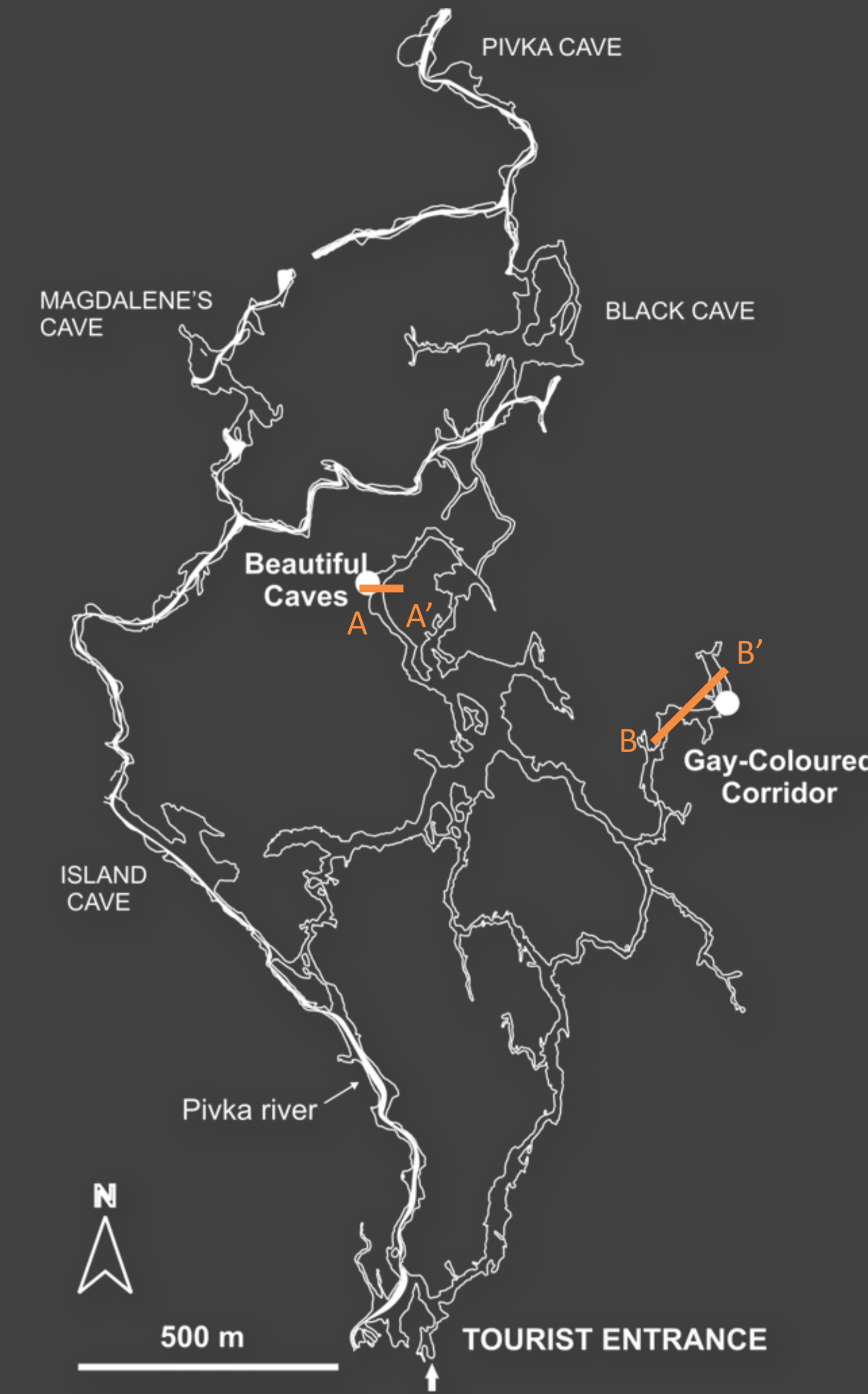


Fig. 1: The passages of Postojna Cave with monitoring sites in the Beautiful Caves and Gay-Coloured Corridor with cross sections A-A' and B-B'.

However summer ventilation regime can be noticed only in the Beautiful Caves (Fig. 4a) when outdoor air temperatures exceed about 25 °C (Fig 5b). Besides seasonal variation also diurnal variation of radon concentration may be noticed in the Beautiful Caves (Fig. 5c), usually during spring or autumn months, when outdoor air temperature varies around 10 °C.

In winter, the ventilation regime in the Gay-Coloured Corridor is similar to that in the Beautiful caves (Fig. 5a), causing radon concentration to decrease, whereas in summer, the ventilation in the Gay-Coloured Corridor stops (Fig. 4b), allowing radon concentration to build up to a constant level around 35 kBqm⁻³ (Fig. 5b). However, a significant decrease in radon concentration in the Gay-Coloured Corridor was noticed during an extreme flood event in September 2010 (Fig. 5d). A sudden rise of the Pivka river level presumably lead to higher air pressure in the cave, compressed the air from the main passage into the Gay-Coloured Corridor.

CONCLUSION

Measurements of radon concentration in two different passages of Postojna Cave, Beautiful Caves and Gay-Coloured Corridor, have shown their specific characteristics. Different geomorphology of both described passages results in different types of ventilation, controlled additionally by atmospheric conditions. This leads to significantly different radon levels in summer and similar radon levels in winter, in both passages. Furthermore, extreme atmospheric events have different effect on radon concentration at both passages.

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